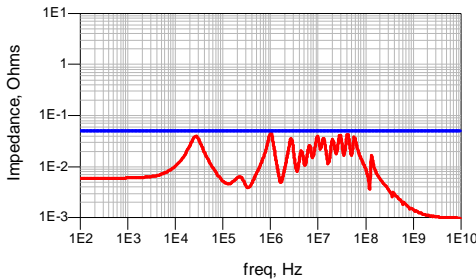


A **1-day** Signal Integrity Class from  
Bogatin Enterprises, a LeCroy Company

# ***PDN: Power Delivery Networks***

*Designing a cost effective and robust PDN*



***Now with hands on labs!***

This one-day class, designed and offered by Signal Integrity Evangelist **Dr. Eric Bogatin**, shows you how to design power distribution networks including the board stack up, capacitor selection and mounting design. More importantly, this class will build your engineering intuition about the behavior of capacitors, planes and systems so that you will be able to perform your own analysis rather than just learn rules to follow. Optimize the power delivery network in your next design with the skills and tools you gain from this class.

Topics covered include:

- How do you select capacitors? How many, what value?
- Where should they be placed?
- When does location matter?
- How will you know if you got it right?
- What's important in the stack up design?
- When is it worth it to use ultra thin laminates?
- What are good habits every layout designer should know?

There are many myths associated with power integrity: just use 3 capacitors per pin, use as large a capacitor value as you can, stack capacitors on top of each other to get them closer to the device, or use surface traces from the capacitor to the power pin. The way to separate myth from reality is by putting in the numbers. In addition to introducing the important principles, a key feature of this class is illustrating how to apply analysis tools such as rules of thumb, approximations and numerical simulations to provide guidance in achieving first time success.

***Now with hands on labs!***

Every PDN design is custom. You can't take one set of rules and apply them to all designs. But many of the important PDN design questions are often answered with "it depends." Unique to this class, you will learn how to use easy to use simulation tools that will help you answer it depends questions in your next design. They each run on a lap top with a Windows operating system. The spreadsheet uses MS Office Excel.

We provide a copy of the tools: an excel spread sheet, from Altera and QUCS, with example files and the training to get you quickly up to speed solving practical problems.

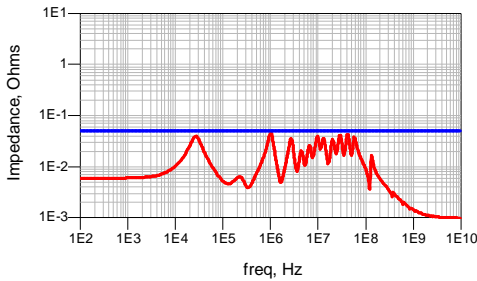
No previous simulation experience is necessary. Even if you have never done any simulation before, you will find these incredibly easy to use and powerful enough to answer important questions.

The labs are home work exercises. Bring your laptop if you want to get started during class..



## **How Do I Register?**

Online at [www.beTheSignal.com](http://www.beTheSignal.com),  
or email [eric@beTheSignal.com](mailto:eric@beTheSignal.com) for questions.



# ***PDN: Power Delivery Networks***

*Designing a cost effective and robust PDN*

## ***Class Outline***

### **PDN Problems and Solutions**

- The impact from rail collapse and the current spectrum
- Establishing a target impedance
- The impedance profile and all of its elements
- What makes a PDN robust and cost effective
- Hands-on-lab: simulating impedance profiles and transient responses

### **Behavior of capacitors**

- Ideal vs real
- Multiple capacitors and the parallel resonance
- Five methods of reducing peak impedances
- Selecting capacitor values and the PDN ecology
- Hands-on-lab: optimizing capacitor values alone and in the PDN ecology

### **When every pH counts**

- Engineering lower ESL
- Five approximations for ESL
- Spreading inductance in planes
- Optimized stack up design
- Hands-on-lab: calculating ESL with a spread sheet

### **Practical tradeoffs**

- Capacitor values, impedance profile and phase: so what
- Reducing parallel peak impedances throughout the PDN ecology
- Example designs: 1 Ohm, 0.1 Ohm, 0.01 Ohms
- Role of planes: when is location important?
- Summary and wrap up